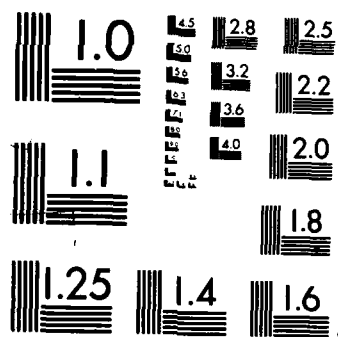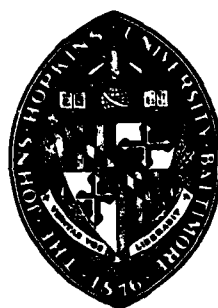AD-A192 840   ASSESSING AND ENHANCING HUMAN PERFORMANCE: UTILITY OF A   1/1
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Assessing and Enhancing Human Performance:
Utility of a Workstation Network

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Abstract

An articulated state-of-the-art network of computer-based workstations has been installed and is being used for behavioral and personnel research. This report describes the network configuration, discusses the current experience in using the equipment, and identifies current research projects that are using the equipment.

Introduction

An articulated state-of-the-art network of computer-based workstations has been installed and is being used for behavioral and personnel research. This report describes the network configuration, comments on the temporary configuration, and discusses the current experience in using the equipment.

The final system was acquired partly with Contract funds and partly with matching funds from the Johns Hopkins University.

Configuration.

The complete system involves a central file server and six Sun workstations. Three of the workstations are monochrome, and three are color displays. The characteristics of the workstations is listed here, together with Sun designations.

Server

> 3/180 with 1/2" tape drive, 380MB disk system, &
>   laser printer

Monochrome workstations

> 3/160 with math coprocessor, multiplexer, & two added
>   terminals

> 3/50 with 142MB disk system, cartridge tape drive system' &
>   two added terminals

> 3/50 standard configuration

Color workstations

> 3/110 19" high resolution color monitor, 71MB disk system

> 3/110 19" high resolution color monitor

> 3/100 15" high resolution color monitor, math coprocessor

Each workstation may have associated terminals attached.

Network

The workstations are connected via a local area network to
the large file server on which the system is maintained and on
which large data bases may be stored. Computing jobs may be done
on the current workstation or on a remote station. Currently,
for example, computation that is heavily statistical is
transferred to a workstation with a math coprocessor. We have
had very good experience moving jobs from one workstation to the
other - this appears to proceed very smoothly. Furthermore, the
network permits easy sharing of less-often used facilities, such
as the printer and the large disk file-server.

At present the local network is operating in isolation from
the Johns Hopkins Homewood Computing Center, because it is
located in the off-campus offices where most of the psychology
department is temporarily housed while the permanent quarters are
being renovated. When the department returns to campus, in Fall,
1988, the complete local network will be interconnected with the
campus-wide network at Johns Hopkins University's Homewood
Campus. It will then have immediate access to arpanet, bitnet,
nsfnet, and other computer interchanges.

At present, one stand-alone workstation, not connected with
the local network, is located on-campus and connected into the
campus network. Again, after a few glitches, the system has been
working very well indeed. Files and programs are routinely
shipped between the workstation and the campus mainframe. Files
of 24000 characters are transferred in a few seconds, with a
speed that seems to the user to be essentially instantaneous.

The local network permits access to other Sun workstations
in the Psychology Department, but not obtained as a part of the
present equipment plan. In particular, the Cognitive
Neuropsychology Lab has three Sun workstations, one of which has
a cassette tape drive, which is useful for transferring data from
the currently stand-alone system and the rest of the network.
We have depended heavily on the programming expertise in that
laboratory to set up our system. Also, programs are conveniently
shared not only between these two labs, but with the biophysics
laboratory of Dr. Terry Sejnowski, as noted below. One of the
stated goals in this installation was the easy sharing of
programs across machines and laboratories, which has already been
amply demonstrated.

It seems possible that there will be a few problems when the
local network and the campus-wide network are interconnected, but
we anticipate no basic difficulties.

We have also linked IBM_PC and IBM-AT systems, in other parts of the Psychology Department, to the Sun Network. This link permits the transfer of data from empirical studies with human subjects that have been run on the IBM-based machines.

Software and systems

We are presently using the Sun's UNIX system, and find that it is very convenient for most work, although some familiarization is necessary. Special statistical packages (SPSS-X) have been acquired for data analysis. Each workstation has one or two substations attached, which can serve as subject stations during experiments, or as extra programming consoles at other times. The Sun UNIX system is easily adapted for multistation use.

Special-purpose statistical programs have been transferred to the Suns. We now have a program for three-mode factor analysis (imported from Dr. MacCallum of Ohio State) and a block modelling program, originally written in Fortran by Knutson and Arabie at Minnesota and Illinois, respectively. The IMSL library is now available to us through a university site license, and provided at no cost to us.

One special use of the software deserves special note. The UNIX-based data management facilities have been put to good use in writing an automated subject pool utility program. Subjects for several of the research projects described below, as well as for other projects in the department can now be randomly selected from the subject pool. Selection criteria (i.e., vision, language) can also be used to satisfy special requirements for individual projects. This utility increases the efficiency of the human subject pool, and reduces the biases that often accompany self-selection methods of subject recruitment.

It should be noted that we have had some problems in using the system for experiments requiring very precise time control of the display. When a display is to be presented for exactly 50 milliseconds, we are having some trouble convincing the system that is what we want to happen. The system is simply not designed with real-time psychological experiments in mind, and we shall have to find ways of subverting it. The displays themselves are ideal for perceptual studies. The solution that we have arrived at involves special-purpose add-on hardware to deal with the timing problem.

Important substantive research is already underway on the equipment by all four of the investigators. Some of that work is described below, to give an appreciation of the kind of work being conducted and the kind of work appropriate for the network.

Motivation and Performance in Small Groups (Dr. Breckler)

A multi-user/multi-tasking computer environment is being developed to study collective decision making situations. Software is being written that will permit the monitoring and recording of information transmission among two or more decision makers located at remote workstations. Programmers are currently working to modify previously-developed microcomputer software to run under the UNIX operating system. Care is being taken to make the software compatible with a wide range of UNIX-based computing systems. Programs are being written in the C computing language, and in the UNIX script language. A number of software utilities have also been installed, including a commercial package of statistical routines (SPSSX).

Models of early perceptual Processing (Dr. Egeth)

Connectionist models of early perceptual processing are under study. The models are elaborate, consisting of several layers, and large numbers of simulated units. Having a workstation permits much more extensive exploration of alternatives than would otherwise have been possible.

Similar comments can be made about efforts to construct more traditional models of early perceptual processes. This work, which has already resulted in two publications, explores the ability to process two (or more) stimuli simultaneously. Model predictions for parallel processing models were contrasted with predictions of complex serial processing models. These comparisons were accomplished easily and quickly on the workstation.

Companion experiments with human perceivers are under development to check the simulations. Several pilot studies have already been run, however the final studies will not be conducted until we have found the best way to configure the system for real-time experimentation. The great advantage of the SUN color workstations is the extensive palette of colors available for creating more realistic approximations to the real world than can be achieved on most computer systems.

Simulations of Computerized Adaptive Tests. (Dr. Green.)

An on-going project supported by the Office of Naval Research (ONR) and by the Navy Personnel Research and Development Center (NPRDC) has been transferred to the Sun workstations. A complete system of Fortran programs has been prepared for simulating the administration of both fixed and adaptive tests of cognitive ability. Computerized Adaptive Tests (CAT) are now being implemented for the Armed Services Vocational Aptitude Battery (ASVAB). The computer simulation programs required slight changes to accommodate the UNIX file system, but the changes were minor and easily effected.

A series of studies has been undertaken of the effect of controlling item exposure (by a random statistical process.) The major result is that a strong degree of control on item exposure can be introduced without affecting the precision of measurement. This counterintuitive result supports the current operational plan for control of item exposure in CAT.

A related issue is the use of content balancing to minimize the bias that results when a unidimensional model is used in situations where a multidimensional model is appropriate. The general result is that content balancing reduces the bias, as expected, without affecting the precision of measurement; this too was expected, in the light of the item exposure study, but extra confirmation is comforting.

Differential Item Functioning (Dr. Green)

A study of the extent to which items on the College Board's SAT Verbal test are responded to differentially by persons of different ethnic background has been done using the Sun for data-processing. The data were obtained from the Educational Testing Service on a tape that was processed by the Campus mainframe computer, read into files that were then transferred to the Sun workstation for initial processing, and then sent forward to the workstation with SPSS-X for continued statistical work. All stages worked smoothly and the results were obtained expeditiously. Although the work might have been done all on the campus mainframe, having the option of rearranging and sorting the data at the workstation was very helpful, and the project exercised the network. All phases went very smoothly.

The main purpose of the study was to demonstrate the methodology. It is clear that the method is useful, and gives a new source of information. However, there are a number of statistical issues that can best be resolved by simulations, which are now being planned.

Connectionist modelling (Dr. Cohen)

A project is under way to examine some of the properties of some connectionist models of human cognition and to evaluate their performance with respect to that of human subjects run in parallel sets of studies. Two specific learning algorithms are being modelled: the Boltzmann learning algorithm and back propagation of error algorithm. In one project, conducted in collaboration with Dr. Michael McCloskey, the sensitivity of these algorithms to proactive interference is being evaluated. The results have documented a large serial-learning effect, whereby the learning of new material is slowed by previous learning of related material, and more striking, the learning of new material causes profound disruption of the previously acquired material. This serial-learning effect has been obtained across a wide range of learning parameters and distributed representational schemes; its magnitude and the speed with which it develops are far greater than seen in comparable situations with human subjects. This project is being supplemented by more formal analyses of the properties of distributed representations in general to identify the locus of the effect.

A second part of the project involves a Boltzmann machine simulation of perceptual learning, comparing the skill learning performance of the model to that of human subjects in detecting the axis of symmetry in checkerboard-based visual patterns. Various versions of the model, embodying different assumptions about biological visual-processing modules, and different numbers of layers of the network, are being explored.

Computer-based Tutoring Project

A study of the different aspects of knowledge available to and employed by learners at different stages in the acquisition of skill is being explored in a computer-based tutoring environment. At present the project is focussing on the interface providing the learner with access to graphic windows that display the problem itself, the learner's progress through the problem space, previously completed problems, help functions and instructions. This is presently being explored in two game environments, Mastermind and an interactive version of Life. The next phase of this project entails solving the problem of real-time data collection capabilities. As mentioned in an earlier section, above, our solution will involve acquiring new hardware for timing.

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